Chapter 2 -- Case Studies in Urban Environmental Design

While the issues and recommended development principles described in the first chapter provide an overview of the shared wisdom on urban redevelopment and stormwater management, it is sometimes hard to make the leap from theory to practical application of these principles. To help make this connection, this manual includes four case studies: actual sites chosen to demonstrate how urban design principles can be combined with best management practices for stormwater in the redevelopment of brownfields and urban neighborhoods. The purpose of this approach is to show how these ideas play out in the real world, using a range of sites with which many people are familiar.

The four case study sites were selected with the help of the project advisory committee. The group provided a list of potential study sites, some of which have previously been the subject of extensive planning, while others have not. Each of these nominated sites was evaluated against the list of issues and design ideas identified earlier in the process. An evaluation matrix identified both the type of site (i.e., waterfront brownfield, historic village infill, urban neighborhood) as well as the type of development (mixed use, housing, industrial, etc). The matrix also evaluated the environmental context of each site, describing whether it was in a riparian corridor or flood zone, close to sensitive wetlands, or surrounded by a residential neighborhood.

Using this approach, the advisory committee and the project team were able to winnow a list of suitable sites down to four which best represented a cross-section of locations and design challenges. Located across Northern Rhode Island, the sites range from central Providence to rural Harrisville, and collectively cover a range of urban design issues common to communities across the region.

The first site, known as the **Stillwater Mill Complex**, is found in the village of Harrisville in the town of Burrillville. Surrounded by what is still a semi-rural landscape (photo at right), the village retains the compact, self-contained character established a century ago. After production of worsted cloth ceased in 1963, the site has had a variety of users, and today supports a mix of service, storage and repair operations -- but nothing on a scale that could take advantage of the site or the remaining mill buildings (right, below).

Recent efforts by the town planning department and the Burrillville Redevelopment Agency, however, have jump-started a process to redevelop the site as the active heart of the surrounding community. Of particular concern are issues of traffic and parking, and the potential impact of redevelopment on the Clear River, which provided the original water power for the site and flows right next to the mills. Plans call for a mixed use center that would be closely tied to the rest of the village with pedestrian paths and greenways.

At the opposite end of the spectrum, in terms of context, the **Rau Fastener** site is embedded in the Elmwood neighborhood of Providence (above). Like many urban mill complexes, the sturdy brick buildings and interesting architectural spaces (below) provide many reuse opportunities, once practical issues of parking, security, and environmental clean-up are solved. The site is typical of older neighborhoods where complexities of ownership, access and permitting can stymie redevelopment. Conversely, the advantages of a walkable downtown location, integrated into the fabric of the surrounding community, offer diverse opportunities for many ventures. Current proposals for the site include affordable and market rate apartments and townhouses, technology-based business offices, and a community day care center.

The third case study is the **Tidewater Site** in Pawtucket. Centered on a 28 acre industrial property on the banks of the Seekonk River (right), the site includes the remains of a former coal gas operation and an electrical generating plant that is still used as a substation by the electric company. Largely unused since the 1950s, the property has been an important element in the city's plans to redevelop the riverfront, which identified opportunities for a continuous waterfront park, along with economic development in the more buildable areas. Potential contamination from former coal gas operations make this the most difficult of the four sites to clean up, but that is more of a financial than a physical constraint. As one of the last available large waterfront parcels in the area, the site has great potential for mixed use office/commercial development. Depending on the market, in the near future this will likely support the necessary clean-up, and allow the site to reconnect the neighborhood to the river, and once again serve as the southern gateway to the city.

The final site consists of an entire neighborhood in **Central Falls** (right). Originally suggested because of potential redevelopment opportunities on the site of the city's DPW yard and the nearby former Dytex plant (below), the study area was expanded to include the surrounding streets and a diverse collection of residential, industrial, and open space uses. The results demonstrate that solving urban design problems and dealing with stormwater runoff often requires looking comprehensively at an entire neighborhood rather than just a single property. Just as trends in stormwater management are moving toward smaller systems that keep runoff close to its source, so redeveloping vibrant neighborhoods increasingly emphasizes actions at many levels, with coordinated participation by private landowners, businesses, and municipal departments.

Public participation and involvement of local stakeholders was an important element in planning for each of the four case studies. For the Stillwater Mill and Rau Fastener sites, much of that work had been done as part of ongoing masterplanning efforts. In those cases, the project team began with plans that were already well under way and took the process a step further by exploring urban design and stormwater management ideas in greater detail. The project team toured the sites and met with the city planners, developers and architects involved with each project. For the Central Falls and Pawtucket sites, the project team led day-long charrettes to explore issues on each site and develop design concepts. In Pawtucket, this included presentations to city officials and staff, and a public workshop at which neighborhood residents participated in the design process.

The results of the four case studies are presented on the following pages, following a common format centered on perspective drawings of each site that compare existing conditions with ideas for future redevelopment. For each site, a general introduction and discussion of existing conditions is followed by an evaluation of opportunities and constraints, and an exploration of the site's relationship to its surrounding context. A plan shows the proposed redevelopment of the site, followed by detailed urban design recommendations for such aspects as parking, architecture, pedestrian circulation, and recreation. Finally, detailed recommendations for stormwater management are presented, along with a discussion of the design objectives behind selection of each practice, and how they fit into state regulations.

This chapter concludes with a discussion of the potential of stormwater BMPs to enhance redevelopment projects, not only from an environmental perspective, but as urban design amenities. This includes ideas for incorporating stormwater ponds and constructed wetlands into new parks, and using green roof technologies to turn hardscapes into greenscapes. What it represents is a largely untapped opportunity to leverage the huge investment that governments and private developers have to make in stormwater management to create wonderful parks and urban amenities that enhance quality of life for urban residents and build value for business.

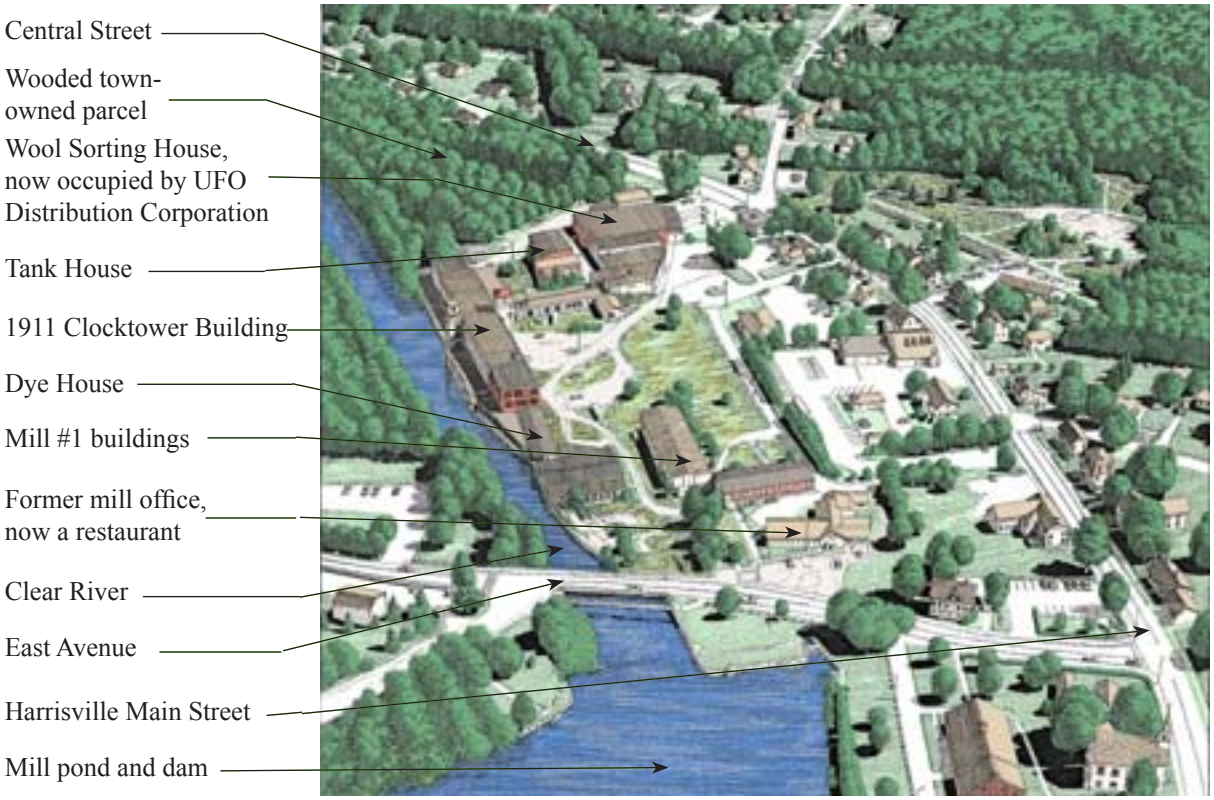
Stillwater Mill -- Existing Conditions Before Redevelopment

Stillwater Mill -- Introduction to the Site

The study area has been in continuous use for almost 200 years, reaching its peak with the construction of the Stillwater Mill in 1911. Reported to be the first mill in the country constructed of reinforced concrete, it was the centerpiece of worsted cloth production until operations ended in 1963. Occupied by a variety of uses since then, the former mill and the surrounding lots included in the study area comprise some 20 different properties totalling 21.7 acres. While some of the buildings have been torn down, those that remain are for the most part structurally sound. Current uses include a fitness center, trucking company, restaurant, and clutch repair operation.

Faced with a complicated site with multiple owners, potential industrial contamination, and abutting a residential neighborhood, the town of Burrillville has been working for years to promote coordinated reuse of the complex. In 2002, the Burrillville Redevelopment Agency selected the Stillwater Mill area as its top priority for designation as a redevelopment district, and sponsored the creation of the masterplan illustrated on the following pages. The masterplan recognizes that the mill complex evolved in close connection with the surrounding village and the natural landscape of the Clear River. Its goal is to redevelop the site so that once again it can be the active heart of the community.

Source: Redevelopment Plan for the Stillwater Mill Redevelopment District. Gates, Leighton & Associates, Inc. and New England Economic Development Services, Inc. February, 2004.



The intimate connection between the mill complex and the river raises environmental concerns, but creates a dramatic design impossible under today's regulations.

Even in its present state, with blocked-up windows and surrounded by a wasteland, the Clocktower Building is the undeniable centerpiece of the complex.

Stillwater Mill -- Neighborhood Context

The Stillwater Mill complex evolved in close conjunction with the village of Harrisville over the course of 200 years. With the help of visionaries like Austin Levy, what was created is a classic mixed use village, combining civic functions like the library, town hall and parks with retail stores, service businesses, schools, homes, and religious institutions. The village remains remarkably compact for a 21st century community, preserving a rare opportunity to evolving into a walkable village where new kinds of businesses once again allow residents to walk to work down a shady Main Street.

Main Street's shaded sidewalks and historic homes.

Classic elements of life on Main Street: a welcoming porch gracing an elegant two-family home.

Small commercial structures naturally meld with the residential character of this historic village, whether it's a small professional office or a car dealership (now the home of Niko's Pizza).

Stillwater Mill -- Opportunities and Constraints

The Clocktower building occupies perhaps the most dramatic part of the site overlooking the river, and is a major landmark for area. High ceilings and tall, narrow proportions would allow successful conversion to residential or business use. Access, parking and potential contamination left from previous industrial uses are the principal constraints to redevelopment.

One of the larger tenants of the site, the UFO Distribution Corporation occupies buildings not easily renovated for business or residential use, nor do trucking and storage uses fit well with the mixed use program envisioned by the masterplan.

Current uses like the Inn at the Falls restaurant have kept buildings occupied, and serve as key stakeholders in planning for redevelopment. The challenge is to coordinate the individual actions of each of these groups -- some of whom must be displaced if the full vision of the masterplan is to be achieved

Traffic and parking are the principal factors limiting the intensity of development on the site. Levels of service are good on main street; the East Avenue intersection is getting more congested, but doesn't yet warrant a traffic light.

The complicated history of the site and multiple owners have resulted in many odd bits of leftover land behind and between buildings that are not being used effectively. By planning comprehensively for all properties at once, these areas can be put to active use as parking and open space to the benefit of everyone in the complex.

The physical structure of Main Street for the most part retains the historic pattern of homes and businesses close to the road, with sidewalks and porches making for a pleasant pedestrian experience. This can easily be reinforced by landscaping the front of existing parking lots, closing unnecessary driveways, and planting new trees. By protecting the streetscape, the uses of adjacent lots can continue to evolve without disturbing the visual character of Main Street.

Abutting uses like the former car dealership on Main Street will certainly benefit from redevelopment of the mill complex, and should be involved in detailed programming as implementation of the masterplan goes forward. Cooperative marketing of available space would benefit all parties.

Stillwater Mill -- Proposed Redevelopment Plan

New town library to be built on the site of former Mill #1, if possible incorporating portions of the former Dye house

New "town common" will be the focal point of the project, reinforced by the surrounding buildings and the main road loop through the site.

Mill #4/ Clocktower Building renovated for 50 mixed-income apartments. Both original reinforced concrete structure and later brick wings will be retained.

Stillwater Heights elderly housing, including 53 apartment units, to be developed by The Community Builders, with grants from U.S. Dept.. of Housing and Urban Development.

Two principal access points connect the main loop road from Main Street to Central Street, and organize interior cross streets and parking areas into a straightforward system. Parking lots interconnected with existing driveways to limit congestion at any one point.

New mixed-use buildings with ground floor retail/ commercial and second floor apartments or condominiums. Parking is provided on both sides of these structures, with the street on the side of the common laid out for short-term parallel parking.

New residential structures, configured as two story townhouses with formal entrances on the street side and parking lots in the rear. If possible, use of shared parking lots could allow more areas to be devoted to open space instead of parking, as shown behind the smaller of the two buildings.

This masterplan was developed by Gates, Leighton & Associates, Inc., of East Providence, RI, with New England Economic Development Services, Inc. of Lincoln, RI, on behalf of the Town of Burrillville and the Burrillville Redevelopment Agency. The Stillwater Heights elderly housing project was designed by Newport Collaborative Architects, Inc., on behalf of The Community Builders, Inc., who also contributed to development of the overall masterplan.

Stillwater Mill -- Proposed Redevelopment

Stillwater Mill -- Urban Design Recommendations

Urban Design Concept:
The masterplan preserves the best of the original mill buildings and uses them as the backbone of a revitalized mixed-use campus. By uniting many abutting parcels into a single master-plan, a common road system, shared parking, and integrated parks and pedestrian circulation systems unite the project into a whole that is much more than the sum of its parts.

Parking:
The masterplan provides spaces, strung around the site in a series of small units that help to minimize the visual impact of the parked cars. A mix of head-in parking and parallel parking, on the main loop road and in separate lots, helps to organize parking for residents and visitors.

A flexible Village Planned Development overlay district allows the required amount of parking to be set using ITE Trip Generation Guidelines, with the approval of the Town Planner and Engineer. This will ensure that the amount of parking will be appropriate for a mixed-use pedestrian center.

Architecture:
New buildings are based on the form and massing of traditional mill village structures. They are organized to reinforce the structure of shared public spaces. Flat-roofed or pitched, they are tall in proportion to their width to maximize the availability of natural light and ventilation. Where feasible, green roofs and solar technologies help to reduce utility costs.

Efficient Use of Space
One of the requirements of successful urban design is that no space be wasted. Sideyards that straddle lot lines can easily be turned into pocket parks, while service areas can double as gathering spaces, as shown here, where the paved area behind the restaurant becomes a temporary cafe in good weather.

Access and Circulation:
Access focuses on two principal entrances leading to the main loop road. Existing driveways and parking areas on adjoining lots are connected and integrated into the new system, which will ease congestion at any one point and provide secondary access points for emergencies. Central bus and van pickup locations encourage use of shared transit options.

Streetscape:
In order to tie the complex to the larger context of the village, the care and attention given to rebuilding its core must extend to the surrounding streets. Sidewalk improvements, new tree plantings, and landscaping of yards and parking lots abutting the street encourage pedestrian use and foster a sense of neighborliness. Closing of curb cuts and driveways that may be unnecessary if others can be shared allows more green space along the street.

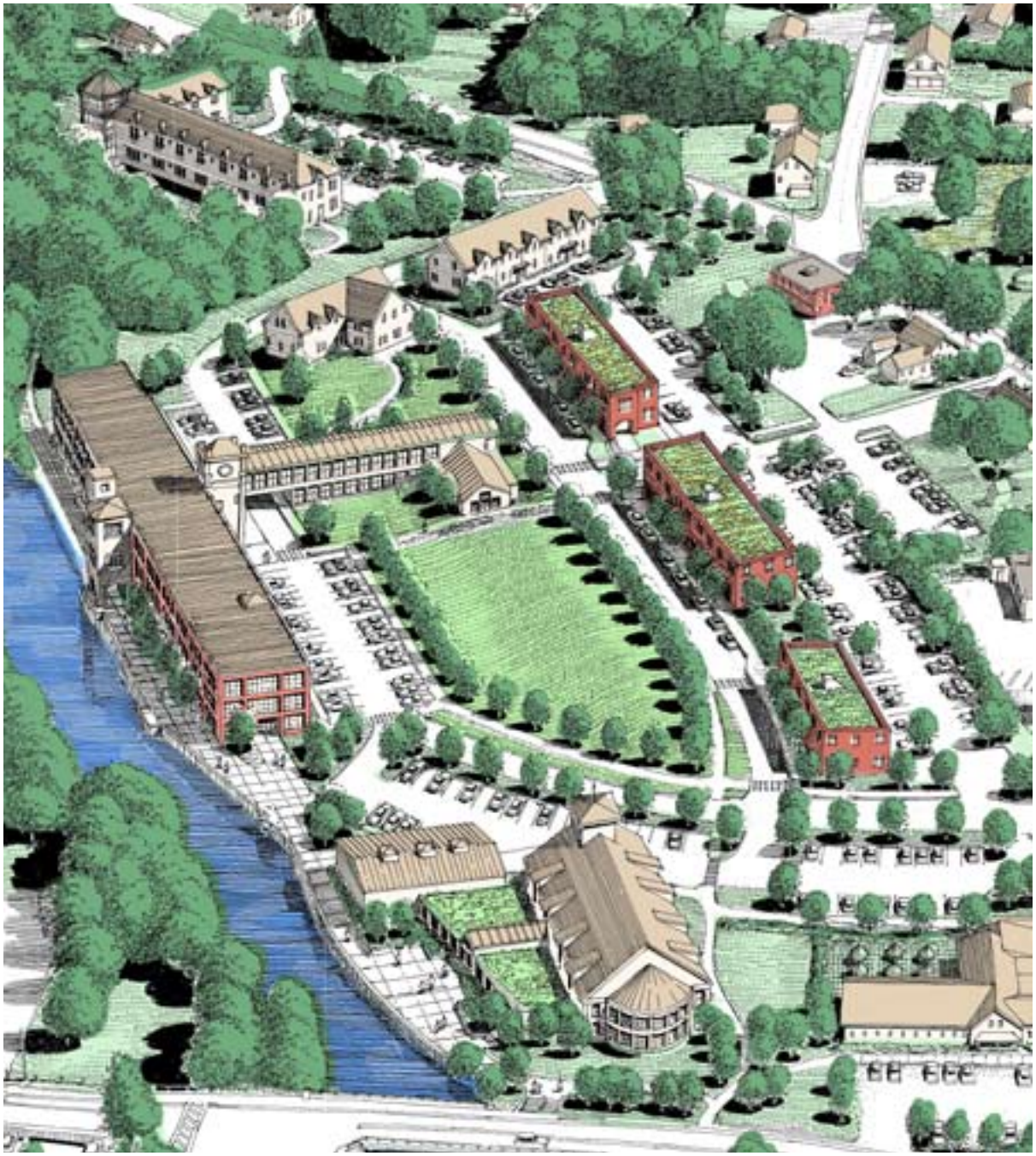
Stillwater Mill -- Urban Design Focus

Creating Community Spaces
In an increasingly competitive market for business, commercial and residential tenants, amenities that support a high quality of life can make a big difference in sales. This has to occur both on the level of the overall masterplan, and in the details of materials and construction. One of the functions of the masterplanning process is to coordinate public and private investments so that paths and plantings don't end at lot lines, and materials, landscaping, lighting, etc.. are the same throughout the area. Key principles include:

Using buildings to shape space: the location and orientation of each building is designed to enclose adjoining pedestrian spaces. Major building features act as focal points that help visitors find their way and create a pleasing visual focus. The result is a series of outdoor rooms that help to organize activities and create a strong sense of place .

Integrated pedestrian system: The roads and buildings help to reinforce a pedestrian spine that connects the Stillwater Heights project to the new library. Secondary connections link each parking area and building to this system, which leads to the common and smaller gathering spaces around the complex. A continuous riverwalk runs along the edge of the Clear River and connects to a townwide trail system.

Gathering spaces form a "string of pearls:"
Public spaces like the riverwalk and garden terrace outside the library, and private gardens, outdoor cafes and sitting areas, are linked into a single system by continuous paths and sidewalks. At the center, the "common" is the most public space in the system, and a natural focus of activity. The surrounding smaller spaces allow users to enjoy a range of experience from a quiet, private garden to a lively community space. The visual and social richness that results will add immeasurably to the success of the project.



Stillwater Mill -- Recommended Stormwater Best Management Practices

Rooftop Garden:
A riverfront deck built on the foundation of the dye house provides an opportunity to combine a terrace gathering space with a rooftop stormwater garden. This could collect the runoff from roofs and store it for gradual use by growing plants, reducing irrigation costs.

Bioretention:
Parking lot runoff is drained into linear filter beds and released slowly back into the ground. These combine the traditional storage and metering function of detention basins with the advantages of filtering by plants and soil.

Green Rooftops:
New construction allows for green roofs to be planned as part of the overall design of the building. While the technology is quite simple, long term success requires careful waterproofing and quality control during construction. Benefits include insulation from extremes of temperature, and protection of roof membranes from sun damage and early failure..

Grid Pavers:
Runoff from many of the parking lots can be reduced with the use of pervious pavement systems. These would probably not be feasible in areas with soil contamination or poor drainage, so much will depend on the more detailed surveys of site conditions that will occur as the project moves forward. Most likely, they will be most useful in higher elevations of the site where drainage is better.

Stormwater Planters:
Planters around the base of the main mill building bring greenery, and a measure of privacy, close to ground-floor windows. Constructed as a continuous engineered unit, the planters absorb and filter roof runoff. Excess water not taken up by the growing plants would be collected by a perforated pipe at the bottom of the planter and carried south to the swale for eventual discharge into the river.

Vegetated Swale:
A low-tech option for areas abutting open space, a vegetated swale allows for efficient sheet drainage from the adjoining road, combined with continuous filtration and infiltration of runoff. While the level of treatment achieved is not as high as for the more highly engineered biofiltration areas, swales provide an inexpensive way to achieve many of the same results.

Stillwater Mill -- Selection and Design of Stormwater BMPs

The Stillwater Mill site is a former industrial complex located immediately adjacent to the Clear River. The site was most certainly filled above the natural floodplain, which creates a number of constraints and opportunities for stormwater management. A riverine floodplain overlaid by fill, coupled with historic industrial uses, suggests severe limitations for infiltration of stormwater runoff. Subsurface soils will likely be ill suited for infiltration of significant amount of runoff and will likely hold contaminants that are better left undisturbed.

Furthermore, because the site is a redevelopment project with little or no increase in impervious cover, and is located immediately adjacent to a major river system, attenuation of peak flows from larger storms may cause more harm than good. In the absence of a watershed hydrologic flooding assessment that designates specific locations and attenuation goals for stormwater flood control, it can be safely assumed that the implementation of quantity controls for this site may actually increase peak flow rates downstream due to the phenomenon of coincident peaks (i.e., runoff from this site is retained until upstream peak flows arrive at the site, thereby resulting in a net increase in peak flow rate in the river).

As a result, the recommended stormwater measures for the Stillwater Mill site are all prescribed to meet water quality control objectives. In general, infiltration practices are not considered for water quality control due to soil/high groundwater limitations and the potential for subsurface contamination. The only exception is the use of grid pavers at a few overflow-parking locations. These would be applied only after a detailed subsurface investigation confirms suitable soils that are contaminant free and only in on-site locations where parking spaces are used infrequently.

Practices selected for the site are listed below and are designed to achieve the following objectives:

- **Rooftop Garden** – Reduction of runoff from rooftop impervious surfaces and overall annual pollutant load reduction;
- **Green Rooftops** – Reduction of runoff from rooftop impervious surfaces and overall annual pollutant load reduction;
- **Bioretention** – Treatment of first inch of runoff from upland impervious surfaces;

Green rooftops can play a valuable aesthetic role in redevelopment, extending landscaping across areas that would otherwise be barren eyesores. Photo courtesy of City of Portland, Stormwater Management Manual, 2002

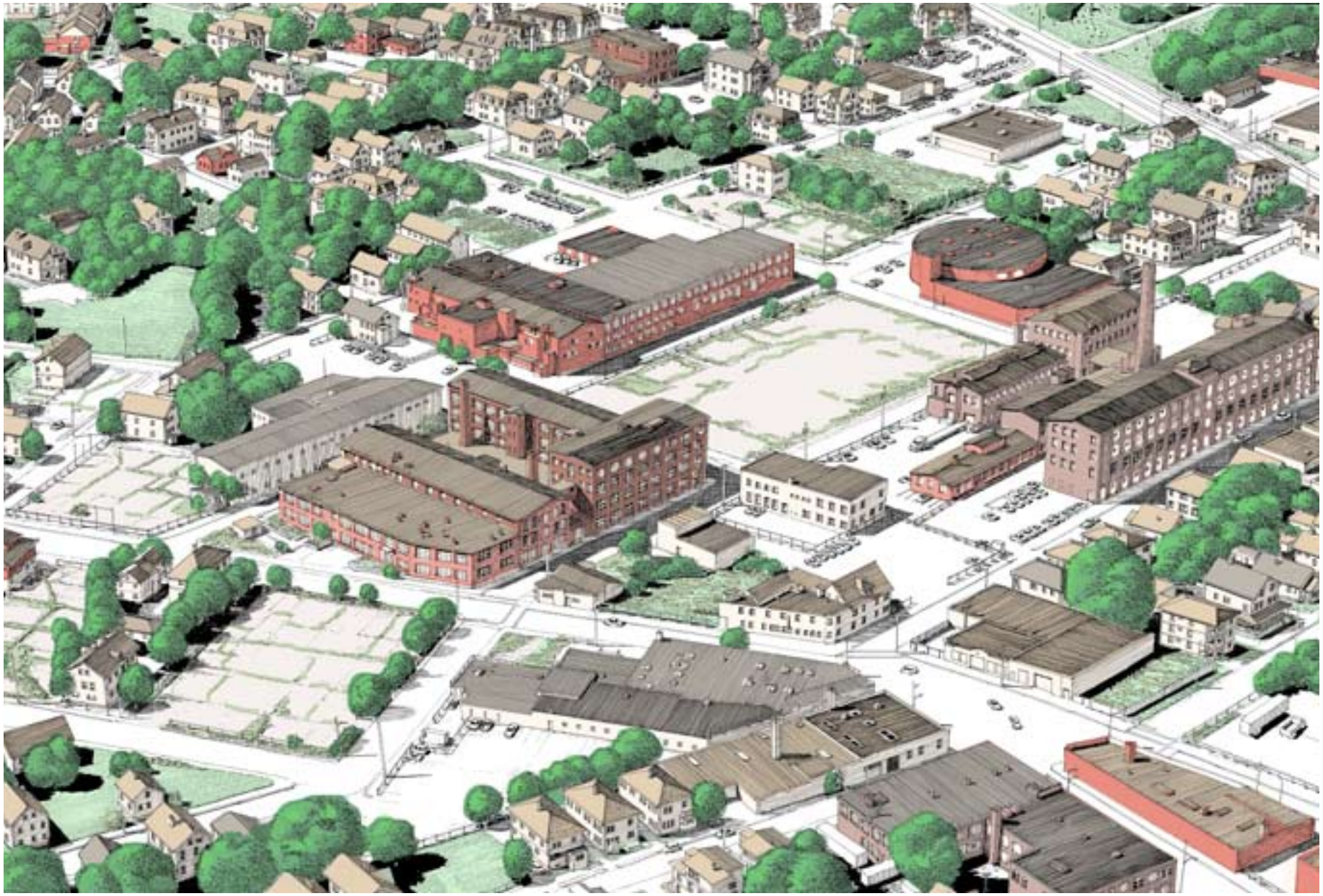
- **Stormwater Planters** – Treatment of first inch of runoff from rooftop impervious surfaces;
- **Vegetated Swale** – Treatment of first inch of runoff from upland impervious surfaces; and
- **Grid Pavers** – Reduction of runoff for area constructed as grid pavers and overall annual pollutant load reduction.

The bioretention systems, stormwater planters and the vegetative swales will provide water quality treatment for precipitation up to the 1-inch storm. The rooftop garden, green rooftops and grid pavers all reduce runoff volume when evaluated on an annual basis. The degree of runoff reduction can vary widely (from 20 to 80%) depending on time of year, rainfall intensity, compaction of the underlying soils, type of grid pavers applied, and whether an "intensive" or "extensive" green roof is employed.

The stormwater management practices applied at the site are designed to be consistent with Rhode Island's stormwater management manual, given the following assumptions:

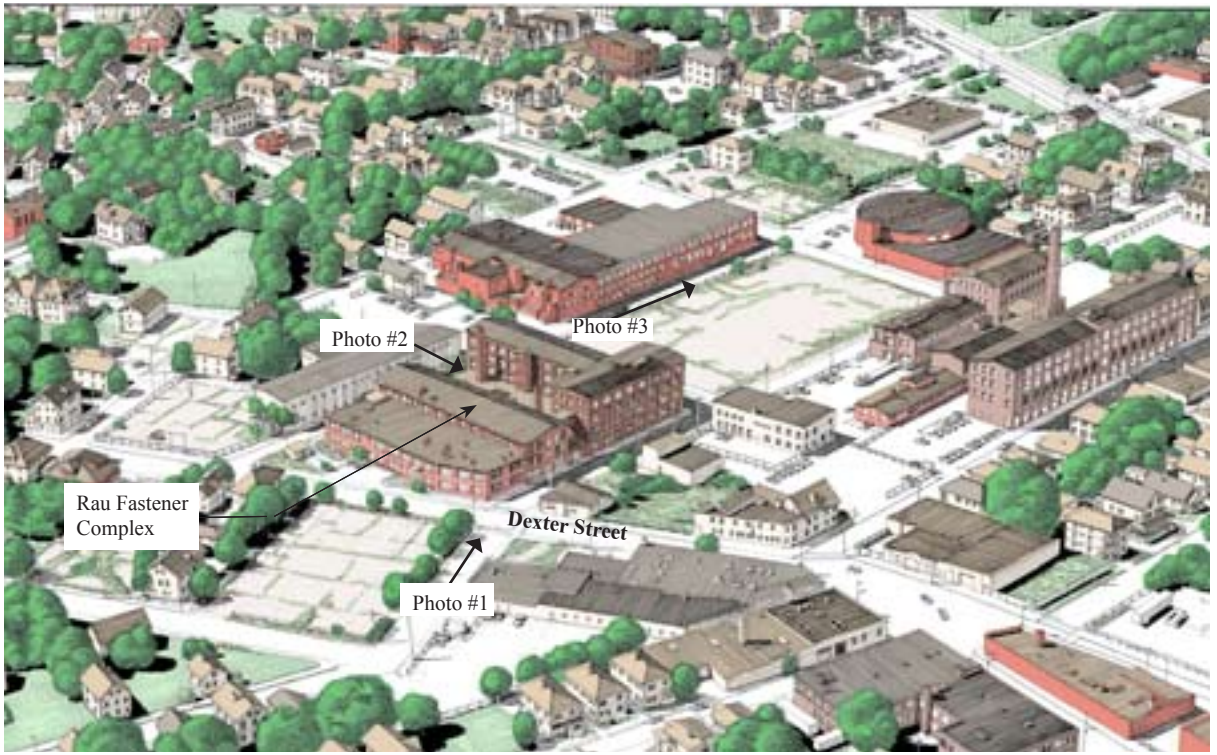
- The redevelopment site will have a net reduction in effective impervious cover, through a combination of green roofs, rooftop gardens, grid pavers, and removal and/or repaving of existing impervious cover;
- Runoff from new roads, parking areas and new buildings will be conveyed to either bioretention facilities, or vegetative swales for water quality treatment;
- Stormwater planters will effectively treat rooftop runoff from the Clocktower Building; and
- Stormwater *quantity controls* are not necessary unless a regional flood control study has identified the site location as necessary for stormwater detention. If the project were located further away from the Clear River and drained to a smaller stream or conveyance channel, additional stormwater quantity controls would likely be required for any increased impervious cover from new parking, roads and buildings.

Rau Fastener -- Existing Conditions Before Redevelopment



Rau Fastener -- Introduction to the Site

The Rau Fastener Complex is embedded in the rich fabric of the West End neighborhood of Providence. In operation from the late 19th century until the 1990's, the complex includes three and four story brick mill buildings, a two story wood mill structure, and a 1950's era two-story addition. Surrounded by a mixture of residential, commercial and industrial uses in a remarkable variety of shapes and sizes, the complex reflects the complicated history of landuse in the neighborhood. While abandonment, decay and disinvestment have troubled the area, the rich historic structure of the neighborhood remains. Renovation and adaptive reuse of the old mill buildings and surrounding residential structures can take advantage of the human scale and strong sense of place left behind by generations of use. Nearby parks, schools, churches and city services create an opportunity for a truly mixed-use, walkable neighborhood.



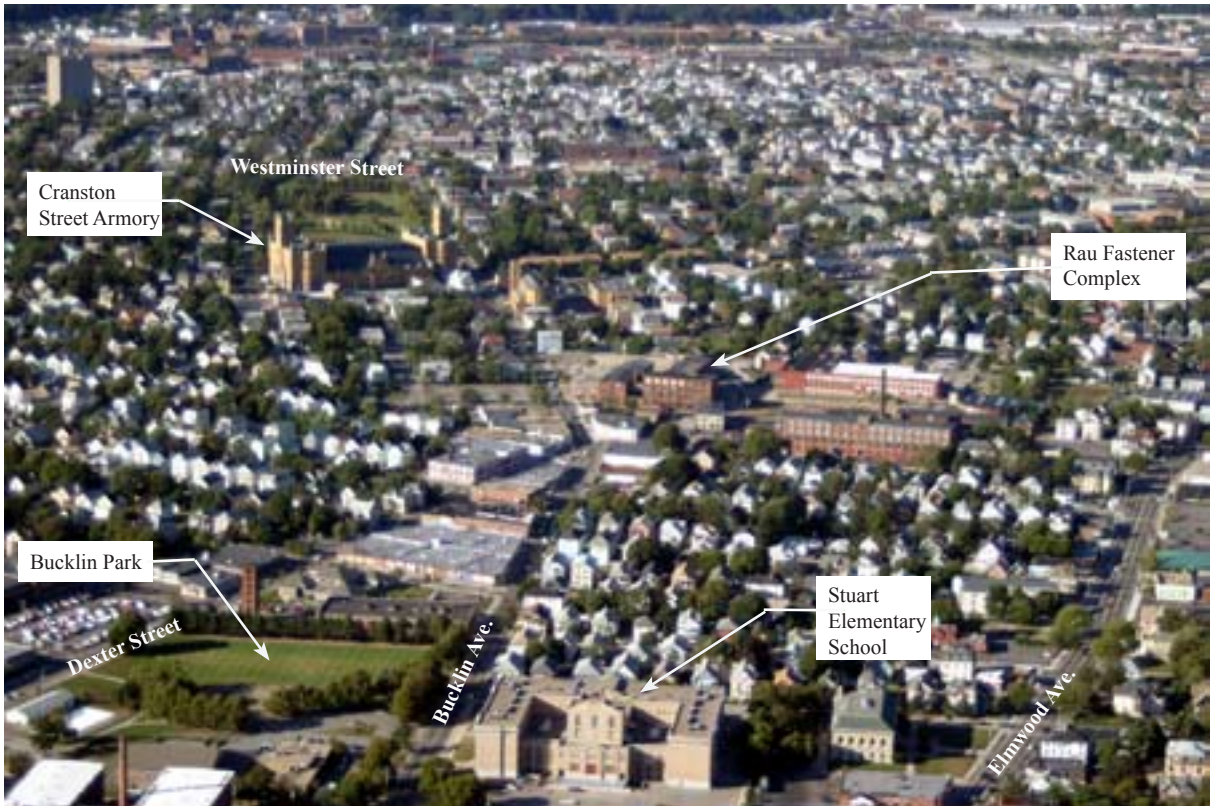
Boarded-up windows and a 1950's addition obscure the historic architectural character of the original brick mill buildings.

The courtyard passage between the two original mill structures offers possibilities for a dramatic entrance to the complex.

A view looking East from the project site down Westfield St. A strong grid of streets ties the complex to the surrounding neighborhood.

The Cranston Street Armory, home of the RI National Guard from 1907-1996, is currently vacant. Together with the adjacent Dexter Parade Ground, it is a major focal point of the neighborhood.

The West End neighborhood is Providence's largest, with almost 16,500 residents in 2000. It is also one of the most diverse, with 30% Hispanic, 18.7% African-American, and 13.1% Asian residents. More than one in three is foreign-born, illustrating the role of the area as a first home for new immigrants. The rich history of the area mirrors economic and social changes in the city since the 17th century, with most structures dating from the boom times that followed the civil war. Like Rau Fastener, many of the industries that powered the neighborhood's growth have moved on, leaving behind a legacy of sturdy brick mill buildings and dense residential streets. (source: Providence Plan).



Nearby residential streets illustrate the rich sense of place created by an earlier society where most people lived and worked in the same neighborhood and walked everywhere they needed to go.

Rau Fastener -- Opportunities and Constraints

A wooden mill building at the north side of the complex is structurally sound, but will need extensive facade improvements and interior renovation to accommodate office and residential use.

The two storey addition from the 1950s obscures the original west wall of the complex, and blocks light to the interior, limiting residential use of the older structures.

Nearby lots, long since paved for parking but currently not used, can easily be adapted to parking for the complex or infilled with housing.

Relatively narrow widths limit traffic volume on any one street, but the grid provides many routes that distribute traffic and reduce congestion at intersections.

Commercial uses along Dexter street create a strong street edge, but fences and boarded-up windows create an unfriendly streetscape.

A large empty lot left after an old mill burned down provides an opportunity for infill development.

Mixed industrial, warehousing and service businesses in similar mill structures surrounding the site may slow initial residential sales -- but the availability of additional mill buildings of a character similar to the Rau Fastener Complex has the potential to support creation of a vibrant neighborhood mixed-use growth center.

Photo Source: Rhode Island Geographic Information System, Color Orthophoto Series.
Photo Date: 2002

Rau Fastener -- Proposed Redevelopment Plan

Wooden mill building will be adapted for mixed-use business occupancy, including community based day care center and technology based business offices.

Historic brick mill buildings will be renovated into sixty-nine affordable and market rate artist studio loft apartments.

Existing residential, commercial and industrial structures are shown in grey. Structures shown in tan include new single family structures as infill on currently vacant lots.

1950's addition to the original Rau Fastener buildings to be razed and replaced with parking and landscaping. Plans coordinated with construction of new bus stop to encourage use of public transportation.

Vacant lots to be paved and landscaped to accommodate the necessary parking for the complex.

A portion of the existing empty lot will be reserved for a new public park with pedestrian paths and plantings.

Twenty-two new three-story attached residential townhouses will be built on vacant lot. Interior alley provides access to rear gardens and garage parking under each unit.

This site redevelopment masterplan and architectural concepts were created for the West Elmwood Housing Development Corporation by Durkee, Brown, Viveiros & Werenfels Architects, Inc. 300 West Exchange Street, Providence, RI 02903.

Rau Fastener -- Proposed Redevelopment

Rau Fastener -- Urban Design Recommendations

Urban Design Concept:
Redevelopment of the old mills and infill of empty lots with townhouses and single family homes is designed to reinforce the historic pattern of streets and blocks in the neighborhood. While the plan accommodates the modern need for automobiles, it is driven by a more traditional pedestrian lifestyle, where broad shaded sidewalks, courtyards and small parks form a continuous system connecting home, workplace, commercial and civic uses.

Parking:
The practical requirements of at least one parking space per dwelling unit force large areas to be turned over to parking lots. While in some urban neighborhoods this can force developers to tear down historic structures for parking, here there are enough empty lots to fit what is needed. As the neighborhood evolves, these can be replaced with garages to accommodate more cars. Meanwhile, on-street parking allows for special events and visitors.

Access:
By maintaining the existing grid of streets, there is ample vehicular access for each building in the complex. Continuous sidewalks and paved gathering spaces minimize conflicts between cars and pedestrians, and encourage use of public transportation. Service and deliveries can be accommodated in marked spaces and off-hour use of street loading zones.

Residential Infill:
New single family homes reinforce the neighborhood character of streets surrounding the complex. Site layout and architectural design can be based on the many historic structures nearby. Parking in side and rear of units allows for an attractive dooryard and streetscape.

Landscape:
With a relatively small proportion of the site not used for buildings or parking, landscaping focuses on pedestrian courtyards and pocket parks integrated into a continuous system of sidewalks and paths. Careful preparation of subdrainage and soils, and planning for irrigation and maintenance allows for heavy use throughout the year.

Streetscape:
The design of sidewalks, dooryards and building facades creates a welcoming public face for the development. Continuous plantings of shade trees shelter the sidewalks, cool parking areas, and filter street noise and dust. Building entrances, porches and stoops are carefully designed to enhance social activities and add to visual interest of the street.

Rau Fastener -- Urban Design Focus

Townhouse Infill for a Vacant City Lot

Rather than trying to turn urban neighborhoods into suburban style subdivisions, use of the traditional city townhouse block, as illustrated here, can reclaim empty lots with a form that uses land and building materials much more efficiently. As a result, the cost of land per unit is more reasonable. Careful attention to the design of the streetscape, and provision of private parking and garden spaces for each unit provide the amenities that residents are looking for in a single family home.

Proposed architectural elevation as developed by Durkee, Brown, Viveiros & Werenfels Architects

Elements of the Townhouse Approach

Efficient building form: the simple continuous building block is inexpensive to build and maintain, while a full three storeys provide large floor area for each unit.

Automobile access: an alley provides vehicular access to the rear of each unit, each of which has a private drive and ground-floor garage.

Private open space: small garden spaces and individual porches provide a private yard in the rear of each home.

Public open space: sidewalks connect each unit to larger park space at the end of the block. Urban living can provide a high quality of life by allowing easy pedestrian access directly from the home to city parks and playgrounds.

Architectural character: simple bay windows and decorative entrances provide visual interest and functionality for each unit.

Classic city living: the combination of broad sidewalks, trees, attractive front facades and stoops is a classic formula for comfortable in-town living.

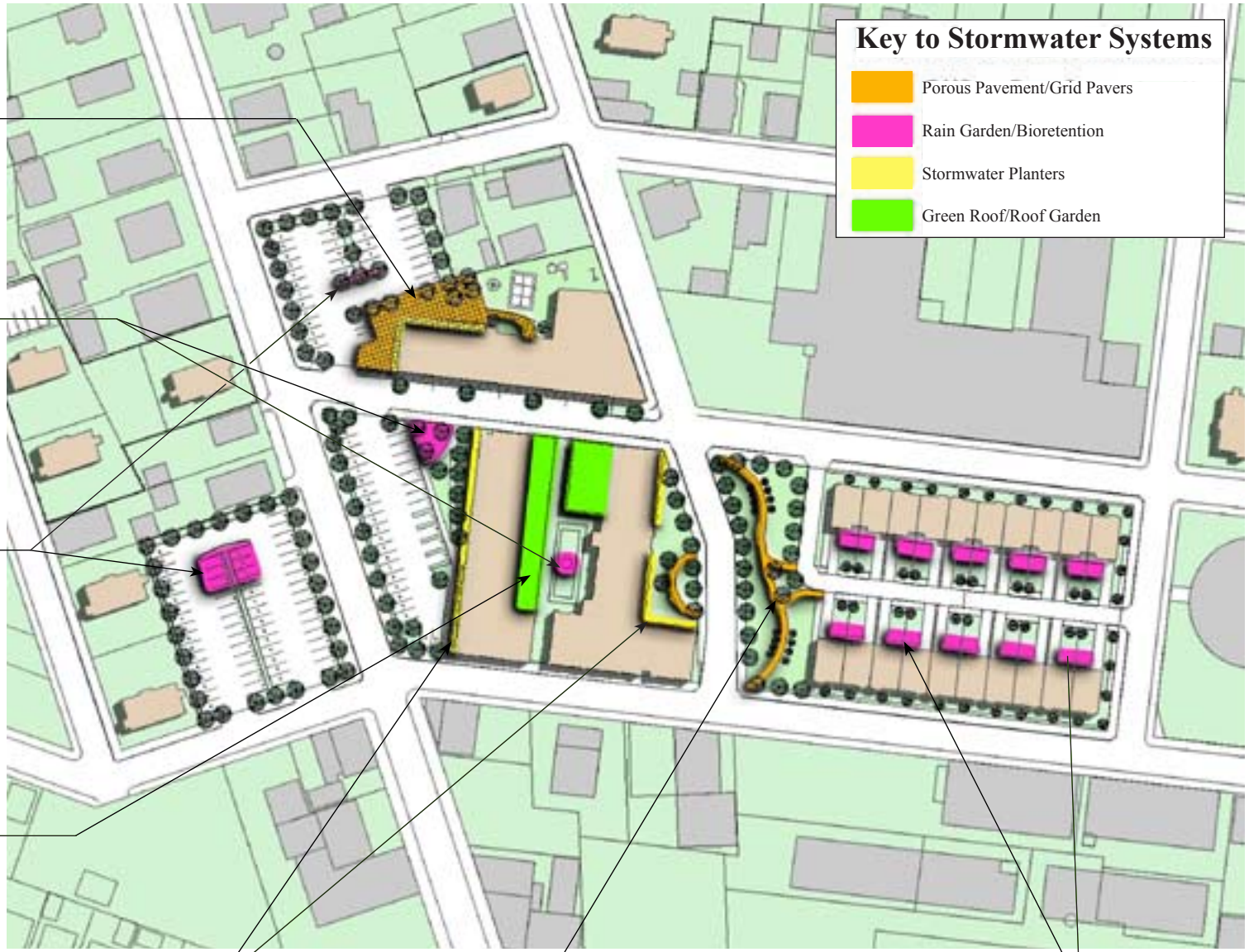
Rau Fastener -- Recommended Stormwater Best Management Practices

Porous Pavement:
Porous paving blocks help to infiltrate rainwater back into the ground, while creating an attractive surface for pedestrian areas around a building entrance.

Bioretention: Parking lot runoff is directed to central locations for filtering and recharge to groundwater.in subsurface drainage beds or chambers..

Lined Bioretention:
Where soil conditions or potential contamination limit potential for infiltration of stormwater, bioretention is used to slow and filter runoff, which is collected by an impervious liner and piped to other areas.

Roof Gardens:
The roof areas of the one story wings surrounding the interior courtyard are sheltered and visible surrounding upper-story windows. Roof gardens here will extend usable outdoor space while providing insulation and summer cooling.



Stormwater Planters:
Planters around the base of the mill structures establish a privacy setback from ground floor windows, while providing for permanent and seasonal plantings that soften the hard edges of the buildings.

Grid Pavers:
Grid pavers help to demarcate pedestrian paths through the park space, while allowing for stormwater to soak back into the ground.

Bioretention/Rain Gardens:
Rain gardens combine the practical function of bioretention and groundwater recharge while providing lush green space outside each home. Careful selection of plant materials ensures year-round visual interest.

Rau Fastener -- Selection and Design of Stormwater BMPs

The Rau Fastener site is completely surrounded by existing development and served by network of subsurface drainage pipes with adequate capacity to carry stormwater runoff away from the project site. The Rau Fastener building itself is viewed as a historic resource and the roof material would need to be compatible with historic preservation objectives. The Rau Fastener site was a former industrial manufacturing operation with documented subsurface contamination in soils immediately below and adjacent to the existing mill buildings. Soils below the proposed parking lots (away from the existing mill buildings) may offer opportunities for the application of infiltration practices. Because the site drains via pipes with adequate capacity to carry the 10-year storm from the project and because there is a net reduction in total impervious cover, stormwater *quantity controls* are not necessary.

Based on the initial site assessment, the recommended stormwater measures for the Rau Fastener site are all designed to meet water quality control objectives. In general, infiltration practices are not considered for water quality treatment due to the potential for subsurface contamination. The only exception is the use of porous pavement blocks for pedestrian courtyards and grid pavers for sidewalks. Both of these areas are located a significant distance from known areas of subsurface contamination. Application of porous pavers would be implemented only after a detailed subsurface investigation confirms suitable soils that are contaminant free and only for pedestrian surfaces.

Practices selected for site are listed below and are designed to achieve the following objectives:

- **Rooftop Garden** – Reduction of runoff from rooftop impervious surfaces and overall annual pollutant load reduction;
- **Bioretention** – Treatment of first inch of runoff from upland impervious surfaces;

Stormwater planters work well in urban neighborhoods where careful design detailing, durability and maintenance requirements are important factors in the success of the project. Photo courtesy City of Portland Stormwater Management Manual, 2002,

- **Stormwater Planters** – Treatment of first inch of runoff from rooftop impervious surfaces;
- **Vegetated Swale** – Treatment of first inch of runoff from upland impervious surfaces; and
- **Porous Pavement Blocks/Grid Pavers** – Reduction of runoff for area constructed as grid pavers and overall annual pollutant load reduction.

The bioretention systems, stormwater planters and the vegetative swales will provide water quality treatment for precipitation up to the 1-inch storm. The rooftop garden, porous pavement blocks, and grid pavers all reduce runoff volume when evaluated on an annual basis. The degree of runoff reduction can vary widely (from 20 to 80%) depending on time of year, rainfall intensity, compaction of the underlying soils, type of grid pavers applied, and whether an "intensive" or "extensive" green roof is employed.

The stormwater management practices applied at the site are designed to be consistent with the goals of Rhode Island's stormwater management manual, given the following assumptions:

- The redevelopment site will have a net reduction in effective impervious cover, through a combination of rooftop gardens, porous pavement blocks, grid pavers, and removal and/or repaving of existing impervious cover;
- Runoff from new roads, parking areas and new buildings will be conveyed to either bioretention facilities, or vegetative swales for water quality treatment;
- Stormwater planters will effectively treat rooftop runoff from the existing mill building; and
- Because the site directly discharges to an existing drainage network with adequate capacity to convey the 10-year frequency storm and because there is no increase in impervious cover, stormwater *quantity controls* are not necessary.

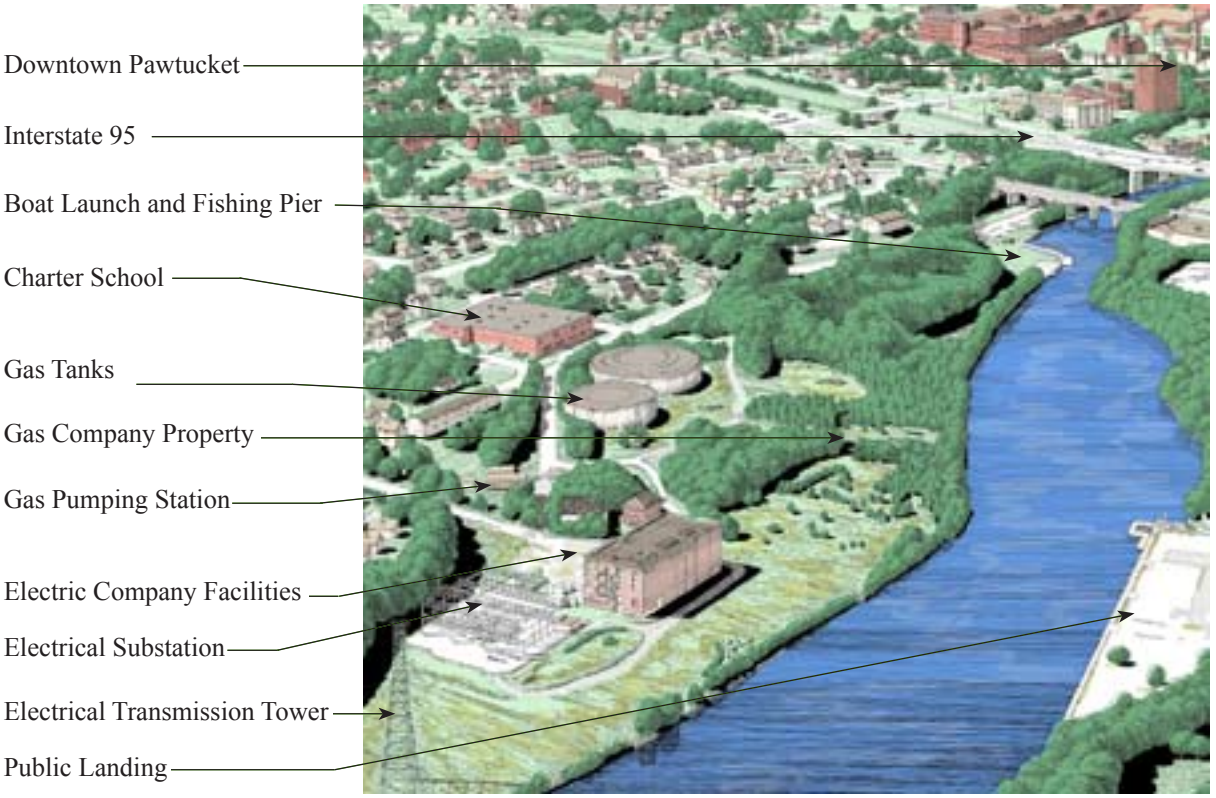
Tidewater -- Existing Conditions Before Redevelopment

Tidewater -- Introduction to the Site

The Tidewater site has been an important part of the City of Pawtucket's vision for the future since completion of a Riverfront Development Plan in 1976. The core of the area is a 28 acre industrial property that includes a former coal gasification plant that operated from 1881 to 1954. Just to the South, Narragansett Electric operates a substation that must remain in place as other areas are redeveloped. To the north, the City's Pawtucket Landing park provides a boat launch and fishing pier, and from there it is less than a mile up river to City Hall.

Potential contamination of the site with by-products of the coal gas plant have long been of concern to residents and city officials, and have delayed redevelopment. Site investigations and feasibility studies completed over the last 20 years have concluded that while contamination is present, it does not preclude reuse of the site. As a practical matter, however, the level of mitigation required for residential use will likely not be economically feasible. As a result the most likely scenario sees the site redeveloped for industrial or commercial use, with a riverfront park connecting the Town Landing with ball fields to the south of the property.

At a workshop in the summer of 2003, city officials and residents helped to develop a series of plan concepts for the site, one of which is illustrated on the following pages. The preferred plans for the study area see a mix of open space and mixed commercial/office development, which would bring economic growth to the city and help to fund reclamation of the area.



The electric company's transmission towers and substation will remain in operation, but the existing brick buildings are no longer needed.

The site commands a dramatic sweep of the river, which will be its principal asset once fences are removed and the site cleaned up.

Tidewater -- Neighborhood Context

The Tidewater site, once merely the anonymous South end of Pawtucket's industrial waterfront, now promises to benefit from a unique location where the Blackstone River meets the tidal waters of Narragansett Bay. Only a few minutes from downtown Pawtucket and I-95, it is the gateway to the South side of the city, which blends nearly seamlessly into Providence's East Side. For the immediate neighborhood, reclamation of the site represents a chance for more open space. Recent masterplans for the river corridor propose a continuous park along the water's edge, balanced by economic development on the interior of the site. Regardless of where and how this balance is finally reached, planning for the site itself holds the promise of creating a wonderful focus for the surrounding neighborhood, and reconnecting its residents to the river.

Hidden from ground level by fences and vegetation, from the air the site is tied closely to the neighborhood.

Quiet residential streets, two schools and recreation fields abut the site.

A city fishing pier at the north end of the site is just a short way from downtown Pawtucket.

Tidewater -- Opportunities and Constraints

The Francis J. Varieur Elementary School was built on land bought from the Blackstone Valley Electric Company in the 1960's. Classes study the river adjacent to the ballfields just south of the site, and would benefit from paved paths to the waters edge.

Neighborhood Streets run at right angles to the waterfront, with sidewalks that would allow residents easy access to the site once fences are removed. The streets also create view corridors from which glimpses of the water can already be seen. Enhancing this visual and physical connection could reconnect the neighborhood to the waterfront.

The city recently completed a boat launch and fishing pier known as the Town Landing, and has concepts showing additional parking and a structure to accommodate water-based transportation. Actively use by fishermen, the site includes several acres of woods and a turnout and parking area off Taft Street. A steep bank separates the river's edge from most of the Taft Street frontage, limiting pedestrian access for all but the most adventurous.

Narragansett Electric, now part of National Grid, will continue to operate a substation on the site. In line with safety policies that prefer that transformers and other equipment be kept outdoors, the large brick building will no longer be needed. New substation equipment can be built further south, making some of the electric company property available for redevelopment.

Quiet since operations ceased in the 1950s, land owned by the gas company includes landfill containing ferric ferrocyanide, a byproduct of the coal gasification process. Studies have shown that these contaminants are stable, and cannot be released by contact with groundwater or leached out into the river. The recommended approach is clean up of the surface layers and capping of landfilled material, allowing reuse for non-residential purposes.

The site of a new hotel, now under plan development, looks directly out on the Tidewater site. Redevelopment of similar sites will become more common as public improvements to river front parks, clean up of former industrial land, and improvements in water quality in the river are completed.

Tidewater -- Proposed Redevelopment Plan

The proposed development provides a flexible range of footprint sizes, allowing for a mix of commercial and office uses. While they may be developed as individual lots, the structures fit within an overall master-plan where access and parking is shared, allowing for the most efficient layout.

Neighborhood streets are extended into the site, inviting residents to walk down to the new park and maintaining view corridors to the river. The design of streets, sidewalks and plantings within the site can be coordinated with streetscape improvements on existing streets to further tie the neighborhood to the Tidewater development..

A new frontage road creates a main entrance to the site adjacent to Pawtucket Landing, limiting the impact of increased traffic on the quiet residential streets of the existing neighborhood. Lined by buildings carefully placed to form a nearly continuous wall, the road incorporates broad sidewalks shaded by trees to encourage walking. Parallel on-street spaces provides for short-term parking.

National Grid will continue to operate a substation on the site, but new facilities will be constructed further to the south as existing ones are upgraded. New fences and planting will provide screening. Unneeded areas along the river will become part of the riverfront park, connecting the Town Landing with the ballfields and accommodating the eventual extension of the Blackstone Bikeway to Providence.

A new boathouse will provide a center for rowing and sailing on the river. Located at the most visible point at the bend in the river, the facility would act as a focal point and landmark both from the land and water sides. Towers, viewing platforms and signal flags used for crew events add visual interest and excitement. During the week, facilities to accommodate school children turn the boathouse into a river education center.

A large informal play field is the focus of activity, framed by trees at either end. Potential extension of the Blackstone Bikepath could be accommodated along the water's edge. Plantings of native trees, shrubs and grasses create a riparian buffer along the edge of the river.

Tidewater -- Proposed Redevelopment

Tidewater -- Urban Design Recommendations

Urban Design Concept:
The masterplan extends the pattern of the existing neighborhood down to the waterfront to create an elegant edge for the community. A new road winds through the site, acting as the seam between a row of mixed-use commercial/ office buildings and a grand waterfront park. With a new boathouse as its focus, the park includes natural areas, forest and informal play fields. The future Blackstone Bikeway winds along the water's edge.

Parking:
Three locations contain most of the parking spaces on the site. Taking advantage of the least visible areas, the lots are located close to the entrance roads, encouraging visitors to park their cars and walk from place to place. Divided into smaller sections by trees and landscaped islands, the number of spaces is minimized by provisions for easy bike access and public transportation. A mix of uses in the buildings promote sharing of parking spaces between daytime workers and night and weekend users.

Building Use and Architecture:
Depending on the cost of mitigating pollution on the site, decontamination to a level allowing residential use may be prohibitively expensive. However, mixed-use commercial or retail businesses, professional offices or research facilities could be accommodated more easily. Keeping building footprints to 5,000 -10,000 square feet allows structures to be designed at a residential scale that fits into the surrounding neighborhood.

Access and Circulation:
The new road that separates the development from the park is the organizing spine that holds everything else together. It is intersected by the grid of neighborhood streets, which are thus allowed to come to their natural destination at the waters edge. Bus and van access is simplified by the simple road loop, which provides convenient drop off locations in front of each of the buildings or at several central bus stops.

Landscape
While no longer an industrial site, the landscape continues to be hard working. Constructed wetlands help to treat stormwater runoff. Trees and woodlands stabilize the riverbanks and provide habitat for wildlife. Clustering development allows large open areas to remain as informal play fields.

Recreation:
A key to attracting businesses to this location is access to recreation. The Blackstone Bikeway, play fields, walking trails, fishing pier and boat launch are all tremendous quality of life assets. The site is a natural site for a boathouse at the edge of the river, which could include refreshments and information for visitors as well as opportunities for rowing and canoeing.

Tidewater -- Urban Design Focus

Integrating Development and Open Space
The most memorable urban places often combine dense clusters of buildings and lively streets with magnificent open spaces. Riverfronts naturally lend themselves to this combination of elements, and have the further advantage of forming a linear connection between key gathering places, each of which can be a focal point for a town or city neighborhood. With this in mind, the design of the Tidewater site should blend open space with developed areas in many different ways, each of which adds to the interest and visual character of the whole:

Structures and Streetscape
The siting of each building is carefully thought out in relation to the street and to other buildings. A common setback line creates a continuous wall, turning the sidewalk into a long outdoor room, sheltered by trees on the street side, and punctuated by gardens and sitting areas. Parallel on-street parking allows visitors to stop outside each building, and views of the park and river will encourage gathering at sidewalk cafes.

Private, Public and Transitional Spaces
One of the keys to successful urban design is to create a system of outdoor spaces with varied degrees of privacy. Directly outside shops or offices there might be private terraces used only by customers or employees; along the street a transitional zone invites window shopping and would be used most by those going to and from buildings; the great open space along the river is the most public part of this system. Visitors from other parts of the city or region would feel comfortable here, as in any public park.

Varied Pedestrian Experience
An environment like this one is best experienced on foot. With care, sidewalks along the street can be linked with paths through the open space to create a continuous network connecting the most important buildings and gathering spaces.. This in turn would be lined to destinations up and down the river by the bike path, and by sidewalks to rest of the neighborhood.

Tidewater -- Recommended Stormwater Best Management Practices

Lined Bioretention:
Potential for subsurface contamination on the site limits the ability to recharge stormwater directly to the ground. Lined bioretention allows water to be filtered slowly through beds at the center and edges of each parking lot. Water drains from the bottom of the filter beds into a perforated pipe for transport to nearby constructed wetlands.

Vegetated Swale:
The length of roadway adjacent to the riverfront park is ideal for a swale, which can be graded to blend in gradually with the open meadow. Longer grasses in the swale slow water flow and filter the larger particles out before discharging the overflow to the wetlands.

Daylighted Stream and Vegetated Buffers:
As with many riverfront industrial sites, old streams were culverted and filled over to make room for industry. By giving up a little space for nature, the stream can easily be uncovered and rebuilt. Plantings of native species help to stabilize its banks and filter runoff from adjoining areas, and weirs and other devices can be used to further settle and aerate stream water before it enters the river.

Stormwater Planters and Cistern:
Runoff from roof areas and decks is directed to planters that soften the lines of the boathouse. Filtered by its passage through the plants and soil of the planters, any excess water can be stored in cisterns for later use irrigating plantings or washing boats and equipment.

Constructed Wetlands:
Land dedicated as park space along the riverfront can be made to serve double duty: helping to deal with stormwater runoff from the site and parts of the adjoining neighborhood. Designed as a series of alternating pools and meandering marshes, constructed wetlands clean the stormwater while adding visual interest and wildlife viewing opportunities for park visitors. In addition to their biological and aesthetic functions, these new wetlands also replace those that historically would have lined the riverbank, once again providing shelter and habitat to wildlife. And like natural wetlands, they are largely self-maintaining, growing and shrinking in response to the available moisture.

Riparian Buffer Plantings:
Large open turf areas can shed water during heavy rains. In this case, low areas adjacent to the river are planted with taller species of native grasses and wildflowers, which slow down the runoff and take up excess nutrients before they reach the river. Seasonal displays of flowers and foliage make a nice counterpoint to mowed turf areas.

Tidewater -- Selection and Design of Stormwater BMPs

The tidewater site is located immediately adjacent to the Seekonk River and much of the site is within the 100-year floodplain. Upland offsite runoff is conveyed through the project location within existing storm drainage pipes, which include streamflow that was at one time above-ground. The Tidewater site was a former electrical generation and fuel processing operation with documented subsurface contamination in soils. Because the site discharges directly to tidal waters of the Seekonk River, stormwater *quantity controls* are not necessary, provided the discharge is non-erosive.

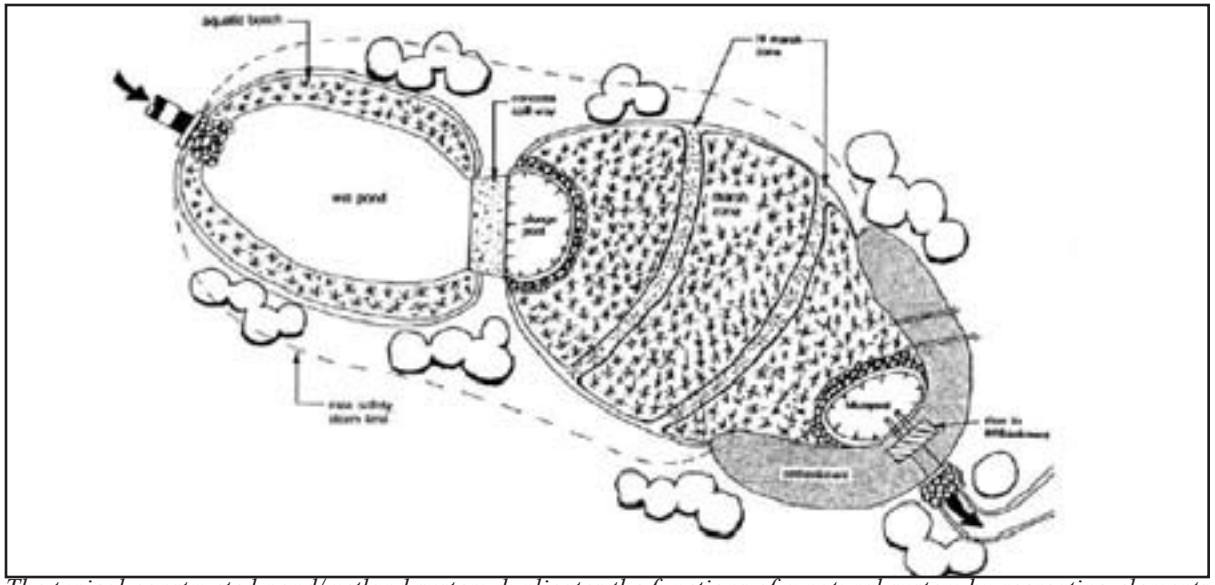
Based on the initial site profile, the recommended stormwater measures for the Tidewater site are all designed to meet water quality control objectives. Infiltration practices are not considered for water quality control due to the potential for subsurface contamination. Because the site discharges directly to tidal waters, and a nearby boat ramp that is a favored fishing location, preference is given to stormwater practices that have higher nitrogen and bacteria removal capabilities.

Practices selected for the site are listed below and are designed to achieve the following objectives:

- **Bioretention** – Treatment of first inch of runoff from upland impervious surfaces and lined to prohibit leaching into subsurface areas;
- **Stormwater Planters** – Treatment of first inch of runoff from rooftop impervious surfaces;
- **Vegetated Swales** – Treatment of first inch of runoff from upland impervious surfaces;
- **Constructed Wetlands** – Treatment of first inch of runoff from upland impervious surfaces;
- **Cistern** – Reduction of annual runoff volume and reduced demand for potable water for irrigation;
- **Native Plantings** – Reduction of runoff and habitat enhancement along the waterfront; and
- **Daylighted Streams and Vegetative Buffers** – Re-establishment of stream habitat and creation of vegetative buffer zones for reducing runoff and stormwater treatment of immediately adjacent areas.

The stormwater management practices applied at the site are designed to be consistent with the goals of Rhode Island's stormwater management manual, given the following assumptions:

- The redevelopment site will discharge directly to tidal waters in a non-erosive manner;



The typical constructed pond/wetland system duplicates the functions of a natural system by recreating elements that allow for aeration and settling of runoff, filtration of contaminants, and absorption of nutrients by living plants. (Source: Schueler, 1992.)

The constructed wetlands, bioretention systems, stormwater planters and the vegetative swales will provide water quality treatment for precipitation up to the 1-inch storm. The native plantings, daylighted stream and vegetative buffers are designed to provide multiple benefits including establishment of aquatic and terrestrial habitats for a variety of flora and fauna, reduction of runoff, protection of stream and river banks from erosion, increased pollutant removal, stream temperature abatement, and providing a corridor for conservation and species migration.

- Runoff from new roads, parking areas and new buildings will be conveyed to constructed wetlands, bioretention facilities, or vegetative swales for water quality treatment;
- Stormwater planters will effectively treat rooftop runoff from the proposed boathouse building;
- The stormwater collection cistern is provided to reduce irrigation needs and reduce net annual runoff volume; and
- Because the site discharges directly to tidal waters in a non-erosive manner, stormwater *quantity controls* are not necessary.

Central Falls -- Existing Conditions Before Redevelopment

Central Falls -- Introduction to the Site

The study area is a neighborhood on the east side of Central Falls. Bounded by a bend of the Blackstone River, the area is bordered on the west and south by railroad tracks. Potential reuse of the vacant Dytex Chemical site as the new headquarters of the city DPW yard will open up the current yard, now on the banks of the river, for redevelopment. Both of these opportunities, together with the ongoing evolution of the area's industrial uses and residential streets, argue for a masterplan approach. Each element should be examined in the context of a potential greenway along the banks of the Blackstone, an opportunity which will benefit the entire city.

Redevelopment of the former Dytex site (left) as the new home of the Central Falls DPW will allow reclamation of the DPW's current headquarters and work yard, now located on the edge of the Blackstone River (left).

Like many old mill towns, Central Falls is moving from an industrial economy of smokestacks and three deckers to an uncertain future. Contrasting land uses and development proposals in the neighborhood illustrate the transitions that the city is going through. Regional attention to the Blackstone River (right) is bringing activity to the waterfront, with a new boat landing and proposed development just North of the study area. The old brick Blackstone Falls Mill was renovated for senior housing. At the opposite end of the study area, a detention center and adjacent junkyard illustrate an earlier view of the river's value. Whatever the future holds, the quality of life created by the continued clean-up of the river, completion of the Blackstone Bikeway and other programs will make Central Falls an even better place to live and work. The city can capitalize on this by planning proactively for the study area.

The proposed Valley Falls Landing capitalizes on public investments in improving the river and river access.

Broad Street is lined with shops and businesses that cater to residents working in local industries .

Quiet residential streets are lined with one, two and three-family homes. Most are neat and well cared-for.

Central Falls -- Opportunities and Constraints

Recent completion of River Island Community Park forges a major link in a potential river greenway connecting Valley Falls Heritage Park with Pierce Park. Wooded banks across the river in Cumberland help to create a natural feeling at the edge of the city.

The city's DPW yard occupies a site at the edge of the river in an otherwise residential neighborhood. The riverbank here is one of the few places that you can get close to the river and enjoy an uninterrupted view of the water.

A variety of light industrial and service businesses occupy a complex of buildings in the center of the site. While there is no reason these should not stay in place, as the river continues to improve as a regional resource opportunities will increase for converting these to uses that take advantage of the river.

Like other junkyards along the Blackstone, this one was probably started when the river was too polluted to appeal to other uses. Now that the river is getting cleaner, it makes little sense to continue using its banks to park cars.

The potential Central Falls Landing project with its new boat docks, along with the completed Blackstone Falls senior housing in a renovated mill across the road, bring a concentration of activity to the north end of the study area. Just across the Broad Street Bridge, the Valley Falls Heritage Park awaits a level of use that will drive away undesirable activities.

The Dytex Chemical Company produced chemicals for swimming pools, but by the 1990s was bankrupt and abandoned. The U.S. EPA was called in under the Superfund program to assess the threat posed by 1,100 drums of flammables, poisons, corrosives and cyanide. EPA worked with RIDEM to safely remove all of these materials, and the site appears to be largely free of contamination. (Source: U.S. EPA New England Web Site.)

Abutting uses, including the Sylvania Plant and mixed commercial, industrial and residential uses along Broad Street, are unlikely to change in the near future. This will likely maintain the population density on and near the study area, a population that will benefit greatly from additional housing and recreational opportunities.

Central Falls -- Proposed Redevelopment Plan

The Blackstone Bikeway crosses over the Broad Street bridge and is routed through River Island Park. Following the river bank, it joins up with the Pierce riverwalk and crosses the Blackstone again into Cumberland on a new bridge at Pierce park.

The former DPW yard is reclaimed as a city park. Parking, a gazebo or concession stand, overlook and boat launch provide amenities for visitors.

New homes (tan) are infilled on empty lots between existing (grey), taking advantage of improvements in the riverfront. Sidewalk and streetscape improvements complete the renovation of the neighborhood.

As the value of riverfront locations increases, new office buildings are built overlooking the park. As industrial uses phase out of older buildings, unneeded wings are removed and replaced with landscaped courtyards. Stormwater gardens designed as part of the landscape help to treat stormwater from roofs and parking lots.

A new residential street is built from the former Dytex building to River Island Park. Replacing what is now trucking company trailer storage, the new homes reinforce the edge of the existing neighborhood and bring new life and activity to the area around the park.

The former Dytex building is renovated for use as DPW offices and garage. Parking and service bays are screened behind landscape islands fronting High Street.

New homes are built to infill vacant lots along high street and complete the row of handsome existing buildings. New sidewalks and street trees along the length of the street help tie new together with old and make for comfortable walking to the parks along the edge of the river.

The junkyard along the river is removed and replaced with multipurpose playfields. Additional parking can be worked in along the edges, while a buffer strip of vegetation is maintained along the riverbank.

Central Falls -- Proposed Redevelopment

Central Falls -- Urban Design Recommendations

Urban Design Concept:
The masterplan preserves and reinforces the best elements of the neighborhood and replaces the misfit uses with those that can take advantage of the increasing beauty and recreational opportunities along the river. The plan is organized around a continuous riverfront park, home to the Blackstone Bikeway, which links existing parks with a new one on the site of the current DPW yard. Streets are renovated and relandscaped, with a focus on High Street, which forms an interior connection between River Island Park and the ballfield complex to the south. Within this circulation loop, the existing neighborhood is encouraged to evolve into a mixed-use, live/work center.

Parking:
Parking is dispersed among many different lots in this scheme. New residences each have their own parking spaces. Small lots provide access at each of the centers of activity in the riverfront park system. Existing parking at the industrial areas is retained, and renovated with planted islands, some of which serve as stormwater treatment facilities. The mixed-use live/work program allows more of this parking to be shared, with employees using it during the day and residents and visitors at night and on weekends.

Access and Circulation:
High Street remains the principal vehicular spine of the neighborhood. Landscaping and closure of unnecessary curb cuts helps to make it more attractive and safe. Attractive new bus stops are located in several key locations to encourage use of public transportation. The grid of intersecting cross streets allows for multiple access to most locations in emergencies.

Streetscape:
Following the time-tested model of the traditional city streetscape, infill structures face the street, with small front yards, fences, porches and stoops all adding to the visual experience and social scene. Continuous rows of street trees shade broad sidewalks. Driveways lead to parking areas in the rear, or are dispensed with altogether in favor of rear access alleys.

Architecture:
New homes follow the tradition of the local vernacular, which affords even very modest structures a certain elegance, and incorporate many techniques for reducing heating and cooling costs. Tall narrow proportions, for example, maximize natural light and ventilation, and tend to look better. Porches and dormers likewise combine visual interest with cost effective construction and livability.

Central Falls -- Urban Design Focus

Evolution of a Riverfront Industrial Area

As the value of the land near the river rises, industrial facilities will gradually be replaced by uses such as offices, research centers and residences that can better capitalize on the river's amenities. As this happens, some of the large industrial spaces will no longer be needed, and can be torn down, allowing light and air to reach the interior. The older mill buildings will be renovated, with new windows looking out on landscaped stormwater gardens. Where appropriate, green roofs will be installed, helping to reduce stormwater runoff and lowering heating and cooling costs. Near the river, new office buildings will be constructed, replacing parking lots and service areas. Since these do not need the large contiguous floor areas of industrial uses, the office buildings can be designed with a footprint and proportions more in scale with the surrounding residential neighborhood. Some of the large existing industrial spaces, meanwhile, can be converted to live/work incubator space for small businesses and artists.

Riverside Landscape:
The edge of the river, set aside as a continuous greenway, is landscaped with native vegetation that help to control surface runoff. Deep rooted, hardy tree species help to stabilize the riverbanks. Invasive species are removed and regular maintenance helps the best existing specimen trees to thrive.

Rain Garden Courtyards:
Careful planning allows the stormwater systems that are needed to control runoff to serve as a beautiful focus for the complex of buildings. Combining ponds for settling with wetlands and running brooks for filtration and aeration, the system provides year round visual interest. Cisterns store excess water for recirculation during dry periods.

Green Streets and Parking Lots:
Streets and parking lots incorporate elements that reduce runoff and add natural beauty. Landscaped islands contain bioretention beds that filter and store runoff from paved areas. Shade trees reduce heating of pavement in the summer and cool the air through transpiration. Hedges reduce the visual impact of parked cars and help filter dust from the air.

Central Falls -- Recommended Stormwater Best Management Practices

Key to Stormwater Systems

- Rain Garden/Bioretention
- Vegetated Swale
- Green Roof/Roof Garden
- Cistern

Bioretention:
Parking lot runoff is drained into linear filter beds and either released slowly back into the ground or collected in perforated pipes for dispersal elsewhere. Growing plants take up nutrients, while subsurface swales help to remove other pollutants.

Rain Gardens:
Rain Gardens do not look much different from any other garden area, but they are carefully designed and constructed below the surface to filter stormwater and recharge it back into the ground. In a new neighborhood with relatively small lots, they are an ideal way to provide a small garden for each home guaranteed to have good drainage and rich soil.

Green Rooftops:
Where appropriate, green roof technology can be incorporated in renovation of old industrial buildings. The section of the Dytex plant slated for use as the DPW's garage is ideal for a green roof. With strong structural support and easy access, the roof could help to treat runoff from both buildings, and reduce heating and cooling costs.

Vegetated Swale:
A long swale intercepts runoff from streets, paths and industrial areas abutting the river. It's particularly useful adjacent to open space areas, where the swale is a natural fit. Combining functions of filtration and stormwater detention, the swale slows runoff and filters out particulates and pollutants both on the surface in the stems and roots of growing plants, and in the soil beneath.

Rain Gardens:
Rain gardens, like other bioretention techniques, are designed to use the natural ability of plants and soils to filter stormwater. Here, rain gardens also play a role in creating a beautiful series of garden courtyards in the middle of an office/industrial campus. Water flows from pond to pond in a system that parallels the paths leading from the campus to the river.

Cisterns:
Cisterns collect roof runoff and store it for use in irrigating ball fields. Since roof runoff is fairly clean compared to that from parking lots, it makes sense to collect and reuse this water instead of flushing it down the storm sewers. Collection requires only a simple system of gravity lines leading to cisterns sized as appropriate to the predicted flow and irrigation use.

Central Falls -- Selection and Design of Stormwater BMPs

The Central Falls study area, located immediately adjacent to the Blackstone River, is drained by an old municipal piping network which combines stormwater runoff and domestic and industrial wastewater flows. During dry weather, all flows are directed to a wastewater treatment plant, but during larger wet weather events, flows may discharge to the Blackstone River, resulting in a combined sewer overflow (CSO). Since many of the redevelopment sites were once part of the industrial uses of the area, the use of infiltration as a stormwater practice is limited. Stormwater management within CSO drainage networks presents unique constraints not found in other situations. While few, if any, new development projects have this situation, it is fairly common in redevelopment projects in older cities and towns.

Perhaps the single most important objective in a CSO drainage network is to minimize stormwater runoff to the combined system, resulting in less runoff entering the pipe system and less frequent overflows to the river. The recommended stormwater measures for the Central Falls planning area are all designed to meet water quality control objectives, while minimizing runoff volume directed to the combined sewer system. Formal infiltration practices are not considered for water quality control due to the proximity to the Blackstone River and likely high groundwater and poor soil conditions, coupled with the potential for subsurface contamination. Incidental infiltration from bioretention facilities and vegetative swales could be a design objective following a detailed subsurface investigation that would confirm suitable soils that are contaminant free.

Practices selected for the planning area are listed below and are designed to achieve the following objectives:

- **Bioretention/Rain Gardens** – Treatment of first inch of runoff from upland impervious surfaces, possibly lined to prohibit leaching into subsurface areas, and designed to promote reduction of runoff to the combined sewer system;
- **Stormwater In-ground Planters** – Treatment of first inch of runoff from rooftops and small lots, and modest infiltration, where conditions allow;
- **Vegetated Swales** – Treatment of first inch of runoff from upland impervious surfaces and reduction of runoff to the combined sewer system;
- **Green Rooftops** – Reduction of runoff from rooftop impervious surfaces and overall annual pollutant load reduction; and
- **Cisterns** – Reduction in annual runoff volume to the combined sewer system and reduced demand for potable water as an irrigation source.

"Rain Garden" Bioretention areas could be incorporated into a continuous system of parks and landscaped courtyards running through the redevelopment area. (Source: Claytor)

The bioretention systems, stormwater planters and the vegetative swales will provide water quality treatment for precipitation up to the 1-inch storm. The green rooftops will reduce runoff volume when evaluated on an annual basis. The degree of runoff reduction can vary widely (from 20 to 80%) depending on time of year, rainfall intensity, and whether an "intensive" or "extensive" green roof is employed. Depending on the application and utility of rooftop runoff collection cisterns, annual runoff volume may be reduced further.

Because the planning area is a redevelopment and infill project, there may be a modest increase in impervious cover, which might warrant attenuation of the larger storms. This is particularly true for any new large impervious surface that drains directly to the combined sewer system. However, much of the land within the planning area is also located immediately adjacent to a major river system and attenuation of peak flows from larger storms may cause more harm than good. In the absence of a watershed hydrologic flooding assessment that designates specific locations and attenuation goals for stormwater quantity controls, it can be safely assumed that the implementation of quantity controls that discharge directly to the river might actually increase peak flow rates downstream due to the phenomenon of coincident peaks (i.e., runoff from this location is retained until upstream peak flows arrive, thereby resulting in a net increase in peak flow rate in the river).

The stormwater management practices applied at the site are designed to be consistent with the goals of Rhode Island's stormwater management manual, given the following assumptions:

- New increased impervious cover will discharge directly to the Blackstone River in a non-erosive manner;
- There will be a net reduction in impervious cover and runoff from redevelopment areas discharging to the combined sewer system;
- Runoff from new roads, parking areas and new buildings will be conveyed to bioretention facilities, or vegetative swales for water quality treatment;
- Stormwater in-ground planters will effectively treat rooftop and surface runoff from the new residential lots;
- Stormwater collection cisterns are provided for an existing large rooftop to reduce runoff to the combined sewer system and reduce irrigation needs; and
- Because much of the redevelopment and infill project area discharges directly to the Blackstone River in a non-erosive manner, stormwater *quantity controls* are not necessary.

Stormwater BMPs as Landscape Amenities

As the science of designing and building stormwater facilities becomes more sophisticated, designers are beginning to explore the aesthetic potential of these elements in the landscape. If stormwater management is a necessary expense in the development and redevelopment process, it only makes sense to maximize the benefit from that investment. Not only can this produce BMPs that are cheaper to build and maintain, but it allows them to serve as valuable landscape amenities rather than mere plumbing.

(Source: Claytor)

With a little forethought, for example, barren rectangular detention basins surrounded by chain link fencing can be naturalized and allowed to serve as a visual focus for surrounding buildings (above). While the natural approach can save on maintenance, the designer needs to understand the way the plantings and the site will develop over time: through this understanding, maintenance can be minimized as the site is allowed to grow in and mature, gradually changing but always attractive. Simplicity is often the key to creating beautiful natural areas, (right), where design is based on simple forms and patterns repeated in endlessly complex and fascinating ways.

(Source: Center for Watershed Protection)

Integrating Stormwater BMPs in New Parks

Planning for new parks, particularly on former industrial land, offers a wealth of possibilities to rebuild natural systems for storing, treating, and transporting stormwater. By studying the form and processes of natural wetlands and ponds, new ones can be created that fulfill many of the same functions. Of equal benefit to the design of public parks, "natural" ponds, streams and wetland systems offer unmatched aesthetic possibilities.

The striking visual character of water and natural vegetation can be heightened by interweaving a chain of wetlands and ponds with a walking path leading to an overlook or gathering spot. Benches, decorative bridges, (right, above) viewing platforms or gazebos can be incorporated as amenities. Wetland-loving trees and shrubs can be used to frame views of water bodies and open lawns or meadow areas, creating a dramatic contrast in form and texture.

Perennial plantings can be used effectively to create a visual focus (right, below). An exciting aspect of working with ponds and wetlands is that they provide habitat for an extraordinary range of shrubs and herbaceous perennials that will not grow in an ordinary garden.

Like any natural ecosystem, a constructed wetland will change over time as flooded areas silt in and trees start to grow. This can be managed with yearly mowing and occasional dredging, or allowed to proceed as part of the natural process. In any case, park users may have to get used to the sometimes messy aspect of wetlands in action. Interpretive displays, nature trails, and brochures can help to educate visitors about the complex functions and interesting ecology of streams, ponds and wetlands.

(Source: Comstock, Stewart)

(Source: Comstock, Stewart)

Turning Hardscapes into Greenscapes

For dense urban sites, where space for structures, parking, and pedestrian circulation is at a premium, there may be little room for parklike amenities. Yet even here stormwater BMPs can be used to soften hard edges and introduce greenery. For example, grid pavers (below) help to slow runoff from the surface of parking areas, while allowing some water to infiltrate. Whether or not they contain growing plants such as the grasses illustrated here, the change in materials and patterns helps to reduce the visual impact of parking lots, while the lighter color and higher moisture levels reduces summer heat absorption.

(Source: Portland, OR)

Courtyards that will be actively used by residents can be designed to include stormwater management functions (right). Careful layout of paths, terraces, and bench locations makes the most use of limited space and clearly separates private and public areas. Permanent plantings of trees, shrubs and hedges establish the structure of the garden and keep things tidy throughout the year. Within the garden beds, seasonal plantings vary from bulbs in the spring to summer annuals and perennials. The beds themselves have been carefully designed to act as bioretention areas, with layers of soil and gravel to absorb and filter runoff and hold it for gradual release, either directly into the ground or piped from the bottom of the bed to the larger stormwater system for the complex.

In many of the urban redevelopment sites illustrated by the case studies, the mix of old and new buildings offers many opportunities for both "extensive" and "intensive" green roof systems. Both offer environmental benefits; just as important are the aesthetic benefits of flowers and greenery, especially in a densely developed site where so much of the land area is devoted to parking lots and buildings. Extensive roof systems, with a relatively thin layer of soil and vegetation, serve from an aesthetic standpoint primarily as a soft green surface. They reduce glare and provide a pleasing contrast to building materials Intensive green roof systems can allow a more traditional roof garden (right). Here, forms and materials are limited only by cost considerations and the bearing capacity of supporting structures. Design is often influenced by whether the garden will be viewed from above or experienced primarily from the surface level.

(Source: Portland, OR)